Solar Magnetic Fields

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The interaction of magnetic fields and plasmas is the root cause of the dynamic, high-energy phenomena of flares, mass ejections, and eruptive filaments observed on the Sun. Thus, in current solar research, extensive observational studies are carried out to develop an understanding of just how the solar magnetic field plays this key role in solar activity. MSFC has a unique instrument for observing the Sun's magnetic field, the MSFC solar vector magnetograph; information derived from observations with it has made significant contributions to an understanding of solar activity. In particular, this instrument permits observations of the transverse component of magnetic fields from which calculations of important solar parameters such as electric currents and magnetic shear can be made; these parameters cannot be obtained from conventional solar magnetographs. Research at MSFC has shown significant correlations of these parameters with the occurrence of major solar flares. Therefore, the MSFC research shows promise in developing techniques to predict major flares. Such predictions will be necessary as the Agency enters the era of the space station, lunar bases, and planetary exploration when people in space will be susceptible to the harmful effects of energetic particles and radiation produced by solar flares.

Over the past year, MSFC's observational program has been reduced since the Sun's cycle of activity is near its minimum phase, during which there is little flare activity. Consequently, more emphasis has been given to analyses of archived data, development of unique data analysis methods and new theoretical models, and instrument development.

Data Analysis and Modeling

Recent accomplishments include new data analysis methods to calibrate vector magnetograph data more accurately, to resolve the ambiguity in the measured azimuth of the transverse field, and to describe more accurately the nonpotential state of magnetic fields. A new theory was developed to extrapolate potential fields for a finite field of view using all three components of the photospheric field. Research carried out recently includes a study of magnetic shear in C-class flares, an analysis of the morphology and evolution of the June 1991 active region that produced some of the most intense solar flares of cycle 22, a study of subflares and surges associated with parasitic polarities, a description of magnetic complexity in terms of fractal dimensions, an analysis of electric currents in active regions, and a study of correlations of magnetic shear with enhanced heating observed in Yohkoh soft x-ray images. Numerous collaborations with scientists from other institutions were also initiated and have resulted in journal publications.

The Experimental Vector Magnetograph

The Experimental Vector Magnetograph represents a state-of-the-art vector magnetograph that will permit measurements of the solar magnetic field with the highest accuracy that modern technology allows. During the past year, the image stabilizer was installed and tested, and modifications of its control software were made to enhance its performance. Magnification optics were designed, fabricated, and installed, permitting tests of the passband variation of the Fabry-Perot spectral filter as a function of angle. Also, a new computer system was installed to handle the large arrays of data from the Experimental Vector Magnetograph, with software being developed to perform the data analysis with this computer.

Moore, R.; Porter, J.; Roumeliotis, G.; Tsuneta, S.; Shimizu, T.; Sturrock, P.; and Acton, L. 1994. Observations of Enhanced Coronal Heating in Sheared Magnetic Fields. *New Look at the Sun With Emphasis on Advanced Observations of Coronal Dynamics and Flares*. Enome, S., and Hirayama, T., eds. Nobeyama Radio Observatory Report, 360:89.

Gary, G.A., and Démoulin, P. Reduction, Analysis, and Properties of Electric Current Systems in Solar Active Regions. *Astrophysical Journal*, 445:92.

Hagyard, M.J., and Kineke, J.I. 1995. Improved Method for Calibrating Filter Vector Magnetographs. *Solar Physics*, 158:11.

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